

Y/PRIS

## METHOD OF FORMING A HOSE

### BACKGROUND OF THE INVENTION

The present invention relates generally to a method of forming a hose to a desired shape by curing a polymeric hose pre-form inside a pre-shaped tube.

Hoses are commonly formed into a desired shape by manually sliding a hose pre-form over a metal mandrel bent to the desired shape. The metal mandrel is usually lubricated to facilitate loading of the metal mandrel in the hose pre-form. The hose is then cured to set the hose to the shape of the metal mandrel. During curing, the metal mandrel supports and retains the hose in the desired shape from the interior surface of the hose. After curing, the metal mandrel is removed. A finishing operation is commonly needed to finish the ends of the hose.

Hoses are also formed by helically winding hose tape around an internal mandrel having a desired shape. The tape is then cured to form the finished hose of the desired shape, and the mandrel is withdrawn.

Another prior method of forming a hose includes confining a hose pre-form inside a spirally shaped confining wall that provides exterior support. The confining wall includes a top half and a lower half. The hose is placed in the lower half of the confining wall, and the top half is then placed over the lower half to trap the hose. The confining wall provides exterior support as the hose is cured. A drawback to this method is that finishing operation is needed because the ends are trapped in the wall and that the confining wall leaves a seam on the hose.

Hoses are also cured while passing through a microwave zone. The outer surface of the tube is simultaneously contacted by a cool stream of fluid that cures the hose. In this method, the outer surface of the tube does not contact any structure or surface.

There are several drawbacks to forming a hose by the mandrel method of the prior art. For one, stress and strain injuries to the operator are possible while sliding of the hose pre-form over the mandrel. This method also requires additional space as there must be room around the parts for the operator's hands during assembly. A separate finishing operation is also required to finish the ends. Finally, this method is expensive and very difficult ergonomically.

### SUMMARY OF THE INVENTION

A polymeric hose pre-form is inserted into a pre-shaped tube and is formed into a desired shape. The hose pre-form is first cut to a desired length. A first end of the hose pre-form is inserted into a loading end of the tube. Preferably, the first end is 5 lubricated to assist in loading of the tube. After loading is complete, the outer surface of the hose contacts the inner surface of the tube.

A vacuum endcap is positioned on an opposing vacuum end of the tube. A vacuum applied at the vacuum endcap draws the hose pre-form through the tube until the first end of the hose is flush with the vacuum endcap. A loading endcap is then 10 positioned on the loading end of the tube. Preferably, both ends of the hose are flush with the endcaps and a finishing operation is not needed.

The hose is then cured to maintain the hose in the shape of the tube. After curing, the loading endcap is removed from the tube, and the cured hose is removed from the tube from the loading end.

15 If the inner diameter of one of the ends of the hose is required to be made larger or flared, a mandrel or plug is inserted into the desired end of the tube prior to curing. The mandrel or plug increases the size of the inner diameter of the hose. These and other features of the present invention will be best understood from the following specification and drawings.

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### BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can 25 be briefly described as follows:

Figure 1 illustrates a schematic perspective view of the hose forming assembly of the present invention; and

Figure 2 illustrates a schematic cross-sectional view of the loading end of the tube after insertion of a mandrel or plug to enlarge the inner diameter of the hose.

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**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Figure 1 illustrates the hose forming assembly 10 of the present invention. The assembly 10 cures and forms a polymeric hose pre-form 12 into a desired shape. The hose 12 is cured and formed to the desired shape in an external supporting tube 14. The hose 12 can be formed of any polymeric material that cures, such as rubber or plastic. Preferably, the tube 14 is formed of a high temperature plastic, glass, Pyrex, ceramic, or a metal, such as aluminum or stainless steel.

The uncured hose pre-form 12 is first cut to a desired length. A first end 16 of the hose pre-form 12 is inserted into a loading end 18 of the tube 14. During loading of the hose 12, the tube 14 is held stationary by a clamping block. Preferably, the first end 16 is lubricated to assist in loading. As the first end 16 of the hose 12 is pulled through the tube 14, the lubrication spreads over the surface of the hose 12 to further assist in loading. The outer surface of the hose 12 contacts the inner surface of the tube 14 that defines the desired shape when loading is complete.

A vacuum endcap 20 is positioned on an opposing vacuum end 22 of the tube 14. A vent tube 24, such as a roll pin, is inserted into the vacuum endcap 20. The vacuum endcap 20 determines the outer diameter of the hose 12 as the point of contact of the endcap 20 and the hose 12. The vent tube 24 determines the inner diameter of the hose 12 as the point of contact of the vent tube 24 and the hose 12. A vacuum 26 connected to the vent tube 24 applies a vacuum that draws the hose 12 through the entire length of the tube 14 until the first end 16 of the hose 12 is flush with the vacuum endcap 20. The vacuum 26 is stopped once the hose 12 is positioned in the tube 14. Although a vacuum 26 is disclosed, it is to be understood that other methods can be employed to draw the hose 12 into the tube 14. For example, the hose 12 can be manually pulled into the tube 14.

As shown in Figure 2, a loading endcap 28 is positioned on the loading end 18 of the tube 14 after the hose 12 is positioned in the tube 14. The loading endcap 28 can also be employed to determine the inner diameter and outer diameter of the hose 12 at the loading end 18 of the hose 12. Preferably, the hose 12 is pre-cut to a length such that the second end 30 of the hose 12 is also flush with the loading endcap 28. The tube 14 is then removed from the clamping block.

The hose 12 is then cured to form the hose 12 in the shape defined by the tube 14. As known in the art, the hose 12 is cured at the appropriate time and temperature for the specific hose material utilized. In some examples, the hose 12 is cured by submerging the hose 12 and tube 14 in a fluidized bed of hot fluid (oils, 5 salts, water). The hose 12 can also be cured by hot air, by an electric wrap, or by microwave. During curing, the pair of endcaps 20 and 28 are flush against the first end 16 and opposing second end 30, respectively, of the hose 12. The endcaps 20 and 28 create a flat surface for curing and eliminate the need for a finishing operation.

10 After curing, the loading endcap 28 is removed from the tube 14, and the cured hose 12 is removed from the tube 14 at the loading end 18. Any suitable pressure may be employed to unload the hose 12 from the tube 14. Preferably, a blowgun is employed at the vacuum end 22 to force the hose 12 out of the tube 14.

15 The inner diameter of the hose 12 is determined by extrusion. During curing, the hose 12 is subjected to pressure. As the endcap 20 includes a vent tube 24, the pressure on the inside and the outside of the hose 12 is equalized, preventing the hose 12 from collapsing during curing. One of the endcaps 22 and 28 must be allowed to vent to equalize the pressure inside the hose 12. In Figure 1, the endcap 22 is vented by the vent tube 24.

20 Preferably, the tube 14 includes a plurality of bends. After the hose 12 is cured and removed from the tube 14, the hose 12 retains the shape of the plurality of bends of the tube 14.

25 Preferably, the outer diameter A of the hose 12 is slightly less than the inner diameter B of the tube 14 to ease in loading. In one example, the hose 12 has an outer diameter A of 9/16 of an inch and is inserted into a tube 14 having an inner diameter B of 11/16 of an inch and an outer diameter C of 12/16 of an inch. In this example, the endcaps 20 and 28 each have an outer diameter D of 11/16 of an inch. The wall thickness E of the hose 12 is preferably greater than 0.065 of an inch in thickness to prevent the hose 12 from collapsing or tearing when bent to the desired 30 shape. Although these dimensions have been described, it is to be understood that the hose 12 and the tube 14 can have other dimensions.

The inner diameter  $F$  of one of the ends 16 and 30 of the hose 12 can be made larger or flared by inserting a plug or a mandrel 32 into the desired end 16 and 30 of the hose 12 to increase the inner diameter  $F$  of the hose 12 at the desired end 16 and 30. Figure 2 illustrates a hollow plug 32 inserted into the second end 30 of the hose 12. Although it is illustrated and described that the plug 32 is being inserted into the second end 30 of the hose 12, it is to be understood that a plug 32 can be inserted into the end 16 or into both ends 16 and 30. The plug 32 has a given length and expands the inner diameter of the hose 12 to an enlarged inner diameter  $G$  at the points where the plug 32 contacts the inner diameter  $F$  of the hose 12. As shown, the loading endcap 28 includes a hole 34 to allow for insertion of the plug 32. The length of the plug 32 also depends on the hose 12 requirements and customers specifications. Curing the hose 12 retains the flared shape of the end 30.

The hollow plug 32 allows the inside  $G$  of the hose 12 to vent, preventing the collapsing of the hose 12 during curing due to the pressure on the outside of the hose 12. By providing a vent, the atmospheric pressure on the inner surface and the outer surface of the hose 12 can be equalized. If a plug 24 and 32 is employed at both ends 20 and 30 of the hose 12, the plugs 24 and 32 must be hollow to allow the inside of the hose 12 to vent. If only one plug 32 is employed, the plug 32 can be solid, or a mandrel, as the other end of the hose 12 is open.

Although a hose pre-form 12 has been illustrated and described, it is to be understood that other pre-forms can be utilized. The pre-form 14 can also be a fuel line, a synthetic brake line, a reinforced hose, a non-reinforced hose, a seal or a gasket, either solid, hollow, dense and sponge.

By employing the hose forming assembly 10 of the present invention, the hose pre-form 12 can be easily loaded in the pre-shaped tube 14, reducing operator injuries. Trimming is also not required as the ends 16 and 30 are finished during the curing process. Additionally, less space is required as the assembly 10 eliminates the need for spacial considerations around the parts for the operator's hands. The tubes 14 are also stackable during the curing process, reducing space and allowing for more hoses 12 to be cured in a given area. There is also fewer external markings on the hoses 12. Finally, the assembly 10 is more economic and ergonomic than the prior art methods.

The foregoing description is only exemplary of the principles of the invention. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, so that one of ordinary skill in the art would recognize that 5 certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.